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Abstract

This paper studies how banks simultaneously manage the two sides of their balance sheet and its implications for bank risk taking and real economic activity. First, we analyze how changes in funding affect the supply of bank loans. We then examine how the supply of credit by banks that rely more on wholesale funding changed during periods of low-for-long interest rates and during the recent financial crisis. The findings suggest that contemporaneous changes in wholesale funding are positively associated with large business loans. In addition, we find that banks that rely on wholesale funding tend to increase mortgage loans in a prolonged low rate environment. This is suggestive evidence that these banks may be taking on more liquidity risk by supplying long-term loans with short-term funding. We also find that mortgage lending by banks relying more on wholesale funding increased, a likely result of government policies to increase liquidity in the market during the crisis.

JEL classification: E52, G21
Bank classification: Financial institutions; Financial stability; Financial system regulation and policies; Monetary policy implementation

Résumé

Cette étude examine la manière dont les banques gèrent simultanément l'actif et le passif de leur bilan ainsi que les conséquences de ce mode de gestion sur la prise de risque des banques et sur l'activité économique réelle. Notre analyse porte d'abord sur la manière dont les changements dans le financement influent sur l'offre de prêts bancaires. Nous nous intéressons ensuite à la façon dont l'offre de crédit des banques qui se financent essentiellement sur le marché de gros s'est transformée pendant les longues périodes de bas taux d'intérêt et lors de la récente crise financière. Les changements intervenus parallèlement sur le marché du financement de gros auraient une influence positive sur les volumes de prêts octroyés aux grandes entreprises. De plus, lorsque les taux d'intérêt restent bas pour une période prolongée, les banques qui dépendent du financement de gros ont tendance à augmenter leurs prêts hypothécaires, ce qui pourrait les conduire à une exposition accrue à un risque de liquidité si elles financent les prêts à long terme à partir de fonds à court terme. Nous constatons également que les banques qui font davantage appel au financement de gros ont haussé leurs volumes de crédit hypothécaire, probablement sous l'effet des politiques publiques destinées à soutenir à la liquidité du marché durant la crise.

Classification JEL : E52, G21
Classification de la Banque : Institutions financières; Stabilité financière; Réglementation et politiques relatives au système financier; Mise en œuvre de la politique monétaire

Non-Technical Summary

Understanding how banks manage two sides of the balance sheet (i.e., assets and liabilities) is important for assessing the effects of various shocks through bank lending channels and changes in regulations. Using the regulatory reports of banks in Canada, this paper asks three questions: which categories of loans do banks supply more (1) when wholesale funding and retail deposits increase?; (2) when interest rates are low for an extended period of time?; and (3) during the recent financial crisis?

First, we find that when wholesale funding increases, banks also contemporaneously increase their supply of large business loans. In contrast, when retail deposits increase, banks supply more mortgage and small business loans. These findings are consistent with a business model where the bank manages decisions regarding large business loans and market-based wholesale funding at its headquarters and leaves the management of retail deposits, mortgage and small business loans to the discretion of regional managers.

Second, we find that banks that rely on wholesale funding tend to increase mortgage loans in a prolonged low interest rate environment. This is suggestive evidence that these banks may be taking on more liquidity risk by supplying long-term loans with short-term funding. Finally, we also find that mortgage lending by wholesale-funding-reliant banks increased during the crisis, a likely result of government policies to increase liquidity in the funding market.

1 Introduction

The relationship between the risk-taking behaviour of financial institutions and its effects on the real economy has received much attention due to the events during the recent financial crisis. One focus of such attention is on how financial institutions expand their balance sheets by levering up during economic booms and contract them by deleveraging in economic downturns, i.e., leverage procyclicality of financial institutions. The literature suggests that this leverage procyclicality among financial institutions with market-based funding may contribute to aggregate risks, implying that the balance sheets of these financial institutions should be monitored carefully.[1] Another focus of the literature is on how the risk-taking behaviour of financial institutions changes in a low interest rate environment. Low interest rates for an extended period prior to the recent financial crisis have been cited as one potential cause of the crisis, since they may have led to excessive risk taking by financial institutions. Based on microdata of financial institutions, recent studies on U.S. and European banks show that the degree of risk taking increases when monetary policy rates are low.[2] Understanding these issues is important for policy-makers and regulators as a new international regulatory framework on bank liquidity standards continues to be discussed.[3]

Motivated by these observations, this paper asks three questions: Which categories of loans do banks supply more

I. when wholesale funding or retail deposits contemporaneously increase?;

II. when interest rates are low for an extended period of time?; and

III. during the recent financial crisis?

More specifically, first, given the importance of leverage procyclicality among financial institutions with market-based funding, we study whether there exists a particular channel of balance-sheet ex-

[1] See Adrian and Shin (2010a,b) for U.S. investment banks, and Damar et al. (2013) for Canadian financial institutions.

[2] See Jiménez et al. (2008) for Spanish banks and Altunbas et al. (2010) for U.S. and European banks.

[3] See Basel Committee on Banking Supervision (2009) for a discussion on bank liquidity standards under Basel III.

pansions by looking at the relationships between the types of loans (e.g., all loans, mortgage loans and business loans) and the types of funding (e.g., wholesale funding or retail deposits). Understanding this channel is important for several reasons. The experience during the recent crisis shows that market-based funding (i.e., wholesale funding) is subject to sudden liquidity dry-ups, making it difficult to raise additional debt or to roll over existing debt. If market-based funding is used to finance bank loans, the credit supply and hence the real economic activity associated with these loans (e.g., business loans and productive investment activities) would likely deteriorate. Therefore, this analysis can identify potential linkages between financial markets, financial institutions and real economic activities.

Second, given the increasing number of studies that suggest the existence of a risk-taking channel of monetary policy, we analyze the effects of a prolonged period of low interest rates on credit growth in Canada. Our analysis of financial institution risk-taking behaviour is with respect to both the asset side and the liability side of the balance sheet and mainly focuses on liquidity risk, in contrast to most other studies, which do not incorporate funding variables in their analyses.

Finally, our third question aims to study the supply of bank credit during the recent financial crisis. In Canada, one of the main impacts of the crisis materialized in the liquidity of short-term funding markets. Spreads in these markets increased significantly and trading volume decreased. As a result, the use of wholesale funding in the banking sector decreased by 14% from its peak in November 2008 to its trough in July 2009. Given these observations, we study how banks with differing degrees of wholesale funding reliance changed their supply of loans during the crisis.

Our empirical approach in analyzing these issues is as follows. We use a data set based on regulatory returns, which contains consolidated financial information of all federally regulated depository institutions in Canada, including income statements, balance sheets and regulatory variables. In addition, our data set includes information on outstanding loan amounts at the Canadian provincial level. Using these data, we analyze the first objective by looking at how growth in total loans, mortgage loans and business loans changes contemporaneously with wholesale funding and retail deposits.

Since an important issue in identifying loan supply behaviour is to control for demand factors, we make use of the provincial loan data. The province-level data allow us to control for disaggregated demand factors and isolate changes in banks' loan supply.

Specifically, with regard to the first question to analyze the balance-sheet channels from bank funding to loans, we study the effects of both the level of wholesale funding on the balance sheet and the changes in the level of wholesale funding use (i.e., the flow of wholesale funding). The level analysis tells us how a financial institution's credit supply can depend on its reliance on wholesale funding. Meanwhile, the analysis of how the flow of wholesale funding affects credit supply provides insight into how financial institutions fund particular types of loans and, ultimately, how banks simultaneously manage both sides of the balance sheet. Regarding the second question to analyze bank risk-taking behaviour during extended periods of low interest rates, we introduce an interaction term between monetary policy rates and the use of wholesale funding in order to observe how different types of bank credit are affected through wholesale funding. In doing so, we apply several definitions of extended periods of low interest rates. One definition is novel, where the periods are defined by the combination of low monetary policy rates together with low term premia.[4] Finally, regarding the third question of bank behaviour during the crisis, we focus on how the supply of bank credit changed during the period due to banks' reliance on wholesale funding.

Overall, our findings suggest that wholesale funding plays an important role in the supply of bank credit. More specifically, regarding the first question to analyze the management of bank funding and credit supply, the following three main findings emerge:

1. Banks relying more on wholesale funding (i.e., the level of wholesale funding) have on average higher growth rates in supplying all types of loans under consideration (i.e., total loans, mortgage loans, business loans and large business loans) relative to other banks relying less on wholesale funding.[5]

[4]This definition aims to capture the expectations of banks in real time. In periods when both the monetary policy rate is low and the yield curve is flat, the low monetary policy rate is expected to continue over the horizon of the yield curve.

[5]This finding is consistent with those in Adrian and Shin (2010b) and Damar et al. (2013), who find that wholesale-

2. Banks that raise wholesale funding (i.e., the change in wholesale funding) on average use them to fund an increase in total loans and large business loans.

3. Banks that raise retail deposits (i.e., the change in retail deposits) on average use them to fund an increase in total loans, mortgage loans and small business loans.[6]

These three effects combined imply the following bank balance-sheet management behaviour. Banks with high wholesale funding increase the supply of all types of loans (relatively more than those with less wholesale funding). When doing so, they fund these increases by both raising wholesale and retail deposits since the two funding sources need to be combined to fund the increases in all types of loans according to (2) and (3) above. In addition, findings (2) and (3) are indicative of a centralized or decentralized management structure for different types of loans and funding. On the one hand, since wholesale funding is mainly raised from financial centers and large business loans require adequate funding, it is likely that decisions regarding them are jointly made at the head office, leading to the observation in (2). On the other hand, retail deposits as well as mortgage and small business loans are typically local-market based and, as such, their decisions are likely left for the discretion of local bank-branch managers, leading to the finding in (3).

Moreover, regarding our second question of the risk-taking channel of monetary policy, we find that the risk taking interacts with the level of wholesale funding use. When interest rates are low for extended periods, financial institutions with high levels of wholesale funding tend to increase their supply of mortgage credit faster.[7] Even though mortgage loans are collateralized and thought to be less risky than, say, business loans, this may be a form of potential excessive risk taking in a prolonged low interest rate environment. As seen during the recent financial crisis, as well as some past recessions, housing market collapses are often associated with large recessions.[8] Given

funding-reliant financial institutions tend to expand their balance sheets quickly. The findings in this paper confirm that a channel of such expansion is partly through loans and not only securities. Since the wholesale funding market can be volatile and potentially subject to a sudden dry-up, our findings imply that the supply of large business loans may be affected by such market conditions, also confirming similar findings in the literature.

[6] Although we do not consider small business loans separately, we interpret significant effects on overall business loans and insignificant effects on large business loans as significant effects on small business loans.

[7] We do not find similar results with respect to business loans or total loans.

[8] See Claessens et al. (2008).

that wholesale funding tends to be a volatile and more risky source of funding compared to retail deposits, our finding suggests that banks are taking on higher "liquidity" risk by funding mortgage loans (i.e., long-term loans) with wholesale funding (i.e., short-term funding). In the case of an adverse shock in wholesale funding markets (e.g., a sudden increase in the interest rate from a low level, making wholesale funding more expensive and less available), these financial institutions could face liquidity problems in continuously financing their loans.

Finally, regarding our third question, we find that wholesale-funding-reliant banks increased their lending during the recent crisis. This increase seems to mainly come from mortgages. During the crisis, government policies were implemented to enhance liquidity in the market, and banks relying on wholesale funding may have benefited more from these policies. These banks, however, also decreased the growth rate of their large business loans during the crisis. These two findings together suggest that, while the overall loan growth increased for banks with wholesale funding, there was a shift in the loan portfolio away from large business loans and toward mortgages.

The rest of the paper is organized as follows. In section 2, we review relevant literature in more detail. Section 3 describes our data and methodology, followed by the discussion of results in section 4. Section 5 concludes.

2 Motivation/Literature Review

This study aims to contribute to a number of different (but related) strands in the literature. The literature on the link between financial shocks and bank lending goes back to Bernanke and Lown (1991), who investigate whether a capital shortage can explain the decrease in U.S. bank lending during the 1990 recession. In a similar vein, Peek and Rosengren (1997) examine the international transmission of such financial shocks by concentrating on Japanese-owned banks in the United States.

Another line of literature relevant to this paper is that of wholesale funding. There are two sides to the use of wholesale funding by financial institutions. On the one hand, access to wholesale funding markets can relax funding constraints of traditional banks that rely on retail deposits, improving

efficiency in the bank intermediation of funds (Goodfriend and King (1988)). In addition, uninsured wholesale funds would introduce monitoring of the bank by investors (Calomiris (1999)). On the other hand, banks that rely on wholesale funding may be subject to sudden liquidity dry-ups (Rajan (2006)), as well as to increased volatility of their balance-sheet size, which ultimately could contribute to financial market volatility (Adrian and Shin (2010b); Damar et al. (2013)).

Following the recent financial crisis, a number of studies investigated the link between bank funding, liquidity and lending activity. Using syndicated loan data for the United States, Ivashina and Scharfstein (2010) show that new lending contracted during the crisis, and this decrease was larger among banks that relied on wholesale funding. Allen and Paligorova (2011) reach a similar conclusion using Canadian syndicated loan data. Gozzi and Goetz (2010) generalize these findings to all commercial and industrial (C&I) loans using data for small U.S. banks. Cornett et al. (2011) also use a sample of U.S. banks during the recent crisis and conclude that the drying up of liquidity resulted in a contraction of all bank lending. We aim to generalize the link between bank funding, liquidity and lending activity by considering a longer sample period, which includes both crisis and non-crisis periods.

Given our additional interest in identifying the existence of a "risk-taking channel of monetary policy" in Canada, this study also contributes to the rather extensive literature on the "bank lending" and "risk-taking" channels of monetary policy. The seminal work in this literature is Kashyap and Stein (2000), who established the presence of the bank lending channel, especially for small banks with less-liquid balance sheets. Jiménez et al. (2011) use loan-level data from Spain to confirm the presence of a bank lending channel in Spain. The link between capital and bank lending was examined by, among many others, Kishan and Opiela (2000) for the United States and Gambacorta and Mistrulli (2004) for Italy.

A recent trend in this literature is to investigate whether a "risk-taking" channel of monetary policy exists. Dell'Ariccia et al. (2010) establish a theoretical framework where the impact of a lower policy rate on bank monitoring (i.e., risk taking) depends on banks' capital and their ability to adjust

their capital structure. Using bank balance-sheet data for both the United States and the European Union, Altunbas et al. (2010) argue that unusually low interest rates over an extended period of time increase banks' risk taking. Maddaloni and Peydró (2010) use bank lending survey data to confirm that low interest rates lead to a softening of lending standards, especially for mortgages. Another study that shows the existence of a risk-taking channel is Jiménez et al. (2008), who use loan-level data from Spain. Finally, Paligorova and Santos (2011) analyze bank risk-taking channels using U.S. syndicated loans data. They find that, in episodes of easy monetary policy, loans to risky borrowers tend to have characteristics consistent with lower lending standards. Although our data and empirical approach are slightly different from some of these studies, our preliminary findings appear to complement the consensus in the literature that both the "bank lending channel" and the "risk-taking channel" exist.

3 Data and Methodology

3.1 Data Sources

The data used in the empirical analysis come from a variety of sources. All bank balance-sheet data are from the Tri-Agency Database System (TDS) of the Bank of Canada, Office of the Superintendent of Financial Institutions and the Canadian Deposit Insurance Corporation. These data are a combination of the quarterly "Regional Distribution of Selected Assets and Liabilities" and the monthly "Consolidated Monthly Balance Sheet" forms.

Although the TDS contains information on 224 federally regulated deposit-taking institutions (banks, foreign bank subsidiaries, foreign bank branches, and trust and loan companies), a number of these institutions had to be eliminated from the sample.[9] Foreign bank branches (allowed in Canada after 1999) were dropped from the sample, since they neither report equity (hence their capital ratio cannot be calculated) nor are allowed to engage in retail banking activities. Furthermore, institutions that are fully owned subsidiaries of other banks or trust and loan companies were also eliminated,

[9]For an overview of the Canadian banking sector and the TDS data, see Damar et al. (2013).

since their parent institutions already report a consolidated balance sheet. Finally, any institutions with less than 16 quarters of data for the period 1994Q1–2010Q4 were dropped from the sample. This resulted in a final count of 49 banks and trust and loan companies in the sample.

Provincial house price data and unemployment data were obtained from Statistics Canada, while the quarterly provincial GDP data were provided by the Conference Board of Canada. Finally, the consumer price index and various interest rates were taken from the Bank of Canada Banking and Financial Statistics.[10]

3.2 Empirical Approach

As discussed above, identifying and controlling for demand factors is always an important issue when analyzing bank lending behaviour. One possible approach to disentangling the demand for, and supply of, bank loans is to use microdata at the individual loan level. This approach has been used by studies that look at the syndicated loan market (such as Ivashina and Scharfstein (2010); Allen and Paligorova (2011)) and for countries where a "loan registry" is available (Jiménez et al. (2011)).

In the absence of loan-level data, other studies have concentrated on banks that are limited in their geographical scope. This approach has allowed them to use bank-level balance-sheet data (such as total loans) and still be able to isolate loan supply shocks using cross-sectional differences among banks. For example, Gozzi and Goetz (2010) limit their sample to small U.S. banks that operate in a single market. For a set of banks operating in a single market, changes in loan demand can explain changes in the overall level of lending, but not variations in lending activity across banks.[11] Similarly, Peek and Rosengren (2000) limit their analysis to three U.S. states where Japanese-owned bank penetration was high during the early 1990s. Since both Japanese-owned and domestic banks

[10] Available at http://www.bankofcanada.ca/en/bfsgen.html.

[11] This approach would be harder to implement in banks operating in multiple markets (or nationwide), since the importance of demand conditions in one market may affect banks differently. Using macroeconomic variables, such as the national unemployment rate, is also unlikely to fully control for demand factors, since some banks may be operating in markets where the unemployment rate is different than the national average. In the Canadian case, such an argument can easily be made for banks whose operations are disproportionately concentrated in the East vs. the West.

in these states face the same demand conditions, it is possible to isolate supply shocks through cross-bank variations in lending behaviour.

This study uses a slightly different empirical approach for a few reasons. First of all, comprehensive loan-level data are unavailable in Canada, making it impossible to use an approach similar to the one in Jiménez et al. (2011).[12] Also, the nature of the Canadian banking sector makes it difficult to concentrate on banks that are limited in their geographical scope: the sector is dominated by six national banks that engage in different lending activities. Although smaller regional and/or specialized banks exist, there are too few of them to form a meaningful sample.

There are, however, available regulatory data on the geographical location of Canadian banks' lending activities for the period 1994Q1 to 2010Q4. Specifically, all federally regulated deposit-taking institutions are required to file a "regional distribution of selected assets and liabilities" form that reports the geographical distribution of (on-balance-sheet) assets and liabilities across the ten Canadian provinces, three Canadian territories and "outside of Canada." The availability of this (relatively unique) data makes it possible to control for "local" demand factors and isolate loan supply behaviour. Compared to the analysis of consolidated bank balance sheets, looking at data on a bank-province level can better disentangle loan demand and loan supply. This, therefore, is the empirical approach chosen for this study.

As discussed above, this study aims to answer three main questions. Our first goal is to determine whether there exists a channel between specific types of funding and different types of loans. In other words, we are interested in improving our understanding of how banks contemporaneously manage the asset and liability sides of their balance sheets. The second question aims to investigate whether a "risk-taking channel of monetary policy" exists in Canada, where prolonged periods of low interest rates lead to increased bank risk taking. Finally, the third question aims to analyze how banks' loan portfolios changed during the recent crisis. Although these issues are intimately related, we use different empirical models to fulfill our objectives.

[12] Loan-level data exist for the Canadian syndicated loan market and are used by Allen and Paligorova (2011). However, syndicated loans are not necessarily representative of the overall lending activity in Canada (they are large loans made by syndicates of banks to large corporations) and are not very suitable for our purposes.

3.2.1 Changes in Funding Portfolios and Credit Supply

In order to investigate the contemporaneous management of bank balance sheets, we estimate the following regressions:[13]

$$\begin{aligned}\frac{\Delta(Loans)_{ijt}}{Loans_{ijt-1}} &= \alpha \cdot Funding_{it} + \beta_1 \cdot Size_{it-1} + \beta_2 \cdot HighK_{it-1} \\ &+ \beta_3 \cdot LoanShare_{it-1} + \beta_4 \cdot ProvShare_{ijt-1} + \beta_5 \cdot Merger_{it} \\ &+ \gamma \cdot ProvinceControls_{jt} \\ &+ \theta_1 \cdot IntRate_{t-1} + \theta_2 \cdot \Delta IntRate_{t-1} \\ &+ \theta_3 \cdot \Delta TermRisk_{t-1} + \theta_4 \cdot \Delta DefRisk_{t-1} \\ &+ Qrt_j + Bank_i + \epsilon_{ijt},\end{aligned} \tag{1}$$

where i indexes the banks, $j = 1, ..., 10$ is the province[14] and t is time (in quarters). The dependent variable is the (real) growth rate of different bank lending types, including (i) total loans, (ii) mortgage loans, (iii) total business loans[15] and (iv) big business loans (size greater than $5 million).[16] These loans are not adjusted for impairment, since allowance for impaired assets is not available at the regional level.

The main bank-level variables of interest are related to bank funding within the vector $Funding_{it}$. In order to better address the questions regarding a bank's contemporaneous management of its balance sheet, $Funding_{it}$ includes variables that capture both the *level* and *change* in the use of

[13] Our objective here is to analyze how funding choices affect bank lending, and hence we do not look at potential feedback effects between lending and funding. For an empirical study that incorporates these feedback effects using Dutch bank data, see de Haan and van den End (2013).

[14] Three Canadian territories are excluded from our study.

[15] For commercial lending, it may be desirable to add "unused commitments" to business loans, in a manner similar to Gozzi and Goetz (2010). Unfortunately, unused commitment data are not available at the regional level.

[16] Consumer/personal loans are not included in the analysis due to the nature of the available data. The regional distribution form completed by Canadian banks breaks down "loans to individuals" into three categories: "personal loan plans," "credit card" and "other." The first two of these categories mainly contain lines of credit (credit cards, home equity lines of credit, etc.), for which the limit on the account is a more accurate measure of the quantity of credit supplied. Unfortunately, information on undrawn consumer credit lines is not available at the regional level. The third consumer credit category ("other") is too vague to be included in the analysis.

different funding sources:

$$Funding_{it} = \{\Delta Wholesale_{it}, \Delta Wholesale_{it-1}, Wholesale_{it-1}, \Delta Retail_{it}, \Delta Retail_{it-1}\}.$$

We consider both wholesale funding ($Wholesale$) and retail deposits ($Retail$). Wholesale funding is defined as the ratio of wholesale deposits, banker's acceptances and obligations related to assets sold under repurchase arrangements (repo) to total assets.[17] Retail deposits are specified as the ratio of personal deposits to total assets. $\Delta Wholesale_{it}$ and $\Delta Retail_{it}$ are the contemporaneous *change* in the bank's wholesale and retail funding use ratios, respectively. The first lags of these two variables are also included in the estimation. The analysis of contemporaneous changes both in funding and loan variables directly informs us how banks manage the two sides of their balance sheets when they receive new funding. Although the lagged *level* of the wholesale funding use ratio ($Wholesale_{it-1}$) is also included within $Funding_{it}$, the level of retail deposit use is excluded since it is clearly highly correlated with $Wholesale_{it-1}$.[18]

In the empirical analysis, the potential simultaneity between the dependent variable and $\Delta Wholesale_{it}$ needs to be considered. Wholesale funding can usually be easily changed within a given quarter, making $\Delta Wholesale_{it}$ potentially endogenous. On the other hand, since retail deposits tend to be "sluggish" and difficult to raise (or get rid of) quickly, $\Delta Retail_{it}$ is likely to be exogenous. In order to address the endogeneity of $\Delta Wholesale_{it}$, we construct instruments based on liquidity in wholesale funding markets. As discussed in Damar et al. (2013), liquidity in wholesale markets is an important determinant of the contemporaneous link between asset growth and leverage growth in the Canadian banking sector. In other words, it appears that when wholesale funding markets are more liquid, Canadian banks are more likely to purchase new assets (which can include new loans) using newly raised wholesale funding. Therefore, liquidity in wholesale funding markets together with an indi-

[17] Wholesale deposits are those that are non-personal and not covered by deposit insurance.

[18] For the main analysis, we define funding variables at the bank-time level, it, instead of the bank-province-time level, ijt. While this specification is reasonable for wholesale funding, which is likely managed at the bank headquarters and not at the regional branches, one can argue that regional managers have discretion over retail deposits in their region. In Appendix A, we discuss estimation results with the retail deposit at the bank-province-time level, $Retail_{ijt}$. Main findings are robust to such changes.

vidual bank's exposure to them is a good candidate to instrument $\Delta Wholesale_{it}$, given that it will affect lending only through the availability of wholesale funding.

We first construct three industry-wide liquidity measures for the three wholesale funding sources: repos, banker's acceptances and wholesale deposits. For each bank i in quarter t, we aggregate individual banks' holdings of these funding sources across all banks except bank i (since some banks are large) and derive the quarterly growth rate for each funding source.[19] We additionally multiply them by a bank-specific liquidity measure to convert these instruments into *bank-time* (*it*) levels. This conversion is done by the following procedure: for each bank i we calculate the weight of each wholesale funding source in the bank's entire wholesale funding portfolio. Then for each time period t, we calculate the *portfolio weight* for each wholesale funding source at time period $t-1$.[20] These portfolio weights capture the importance of a particular wholesale funding source for the bank. For example, if a bank has relied heavily on repos at $t-1$, then changes in repo-market liquidity are likely to have a greater impact on its behaviour. Multiplying these portfolio weights with the appropriate liquidity measure yields the following three instruments for $\Delta Wholesale_{it}$:

$$
\begin{aligned}
Repo\ IV_{it} &= \frac{Repos_{i,t-1}}{Wholesale_{i,t-1}} \cdot \Delta Repo\ Liquidity_{-i,t}, \\
BA\ IV_{it} &= \frac{BA_{i,t-1}}{Wholesale_{i,t-1}} \cdot \Delta BA\ Liquidity_{-i,t},\ and \\
Wholesale\ Dep\ IV_{it} &= \frac{Wholesale\ Deposit_{i,t-1}}{Wholesale_{i,t-1}} \cdot \Delta Wholesale\ Deposit\ Liquidity_{-i,t},
\end{aligned}
$$

where "$-i$" indicates a removal of bank i's contribution to industry-wide liquidity measures. With these instruments, we can estimate equation (1) using two-step generalized method of moments (GMM).

We also include additional bank-level variables in the estimation of equation (1). The logarithm of the bank's assets (*Size*) and the ratio of total loans to total assets (*LoanShare*) are variants of variables commonly used in the literature (Peek and Rosengren (1997)). *HighK* is a dummy

[19] All three measures are normalized by the money supply (M2+) prior to calculating their growth.

[20] This lag in the timing of individual-bank funding variables makes them potential candidates for instruments.

variable that takes the value of one if bank i's capital ratio (equity/total assets) is above the median capital ratio for all banks in quarter t. Finally, the dummy variable *Merger* is set at one if the bank was involved in merger/acquisition activity during the previous four quarters, since such activity is likely to impact lending behaviour. The only bank-province-level variable included in the analysis is *ProvShare*, which captures the share of bank i's assets that are booked in province j at time t. This variable can potentially capture not only the importance of province j to bank i's business model, but also any desire of the bank's managers to geographically diversify their assets.

Given that equation (1) is being estimated using an instrumental variable (IV) approach, it is not practical to account for bank-level fixed effects ($Bank_i$) through the inclusion of bank-specific dummy variables. Instead, all variables are demeaned at the bank level, which is equivalent to including dummy variables in the regression (Huynh and Petrunia (2010)).[21] Equation (1) also includes a quarterly fixed effect (Qrt), accounting for any "seasonal" patterns that may exist in bank lending or the bank balance-sheet variables used as independent variables.

As discussed above, the main advantage of this empirical set-up is the ability to control for demand factors affecting the amount of bank lending in a market. These factors can be controlled for by using province-time dummies (as in Gozzi and Goetz (2010)). In this case, the vector *ProvinceControls* includes only province-time dummies. Similar to the bank-level fixed effects, these province-time dummies can be introduced by removing the province-time specific means from all variables (which are already demeaned at the bank level). We also, however, consider an alternate specification where *ProvinceControls* includes province dummies *along with* demeaned province-level macroeconomic variables. The province-level macroeconomic variables used in the analysis are the first and second lags of (i) the change in the unemployment rate ($\Delta Unemp$), (ii) the year-on-year growth in house prices ($\Delta HousePr$) and (iii) the annualized growth rate of real provincial GDP ($\Delta GDPgr$).

The economy-wide macroeconomic variables of interest in equation (1) are the lagged *level* of the real overnight interest rate ($IntRate$) and the lagged *change* in the real overnight rate ($\Delta IntRate$).

[21] The variables that do not vary across banks (i.e., $IntRate_{t-1}$, $\Delta IntRate_{t-1}$, $TermRisk_{t-1}$, $DefRisk_{t-1}$ and $ProvinceControls_{jt}$) are also demeaned for consistency. For these variables, a "bank-level" demeaning is equivalent to the removal of their overall means. The findings remain unchanged if these variables are not demeaned (not shown).

These two variables are included in the analysis in order to capture any effects related to the current monetary policy stance. The spread between the benchmark Canadian government bond with a maturity of 10 years or more and the 3-month Canadian treasury bill is also included in the analysis ($TermRisk$). This term spread can represent the opportunity for banks to borrow short-term funds and invest in long-term assets when the yield curve is steep. The final macroeconomic variable is $DefRisk$, which is the spread between the benchmark 3–5 year Canadian government bond rate and the 3–5 year corporate bond rate. An increase in this "default spread" might indicate increased risk in financial markets, which may influence banks' lending behaviour. All of the bank-, bank-province- and macro-level explanatory variables are lagged by one period to avoid any endogeneity problems. When using the province-time fixed-effects specification, we exclude these economy-wide variables.

3.2.2 Wholesale Funding and Bank Risk Taking during Extended Periods of Low Monetary Policy Rates

The possible presence of a "risk-taking channel of monetary policy" in Canada with respect to different funding portfolios is investigated through the estimation of the following regressions:

$$\begin{aligned}\frac{\Delta(Loans)_{ijt}}{Loans_{ijt-1}} &= \alpha_1 \cdot Wholesale_{it-1} + \alpha_2 \cdot Wholesale_{it-1} \cdot LowLong_t \\ &+ \beta_1 \cdot Size_{it-1} + \beta_2 \cdot HighK_{it-1} \\ &+ \beta_3 \cdot LoanShare_{it-1} + \beta_4 \cdot ProvShare_{ijt-1} + \beta_5 \cdot Merger_{it} \\ &+ \theta \cdot LowLong_t + \gamma \cdot ProvinceControls_{jt} \\ &+ Qrt_j + Bank_i + \epsilon_{ijt}.\end{aligned} \tag{2}$$

Equation (2) is somewhat similar to equation (1), with the level of the wholesale funding ratio as the only funding variable.[22] $LowLong_{i,t}$ is a dummy variable that takes the value of one during periods when the real monetary policy rate is low. The inclusion of the interaction term $Wholesale_{it-1} \cdot LowLong_{i,t}$ is designed to help determine whether the impact of wholesale funding use on loan

[22] We take out the changes in wholesale funding and retail deposits, since the main interest here is to identify the funding type of banks that are susceptible to risk taking.

growth differs during periods of low policy rates. Extended periods of low monetary policy rates (i.e., "low-for-long" interest rates) can induce banks to soften their lending standards by improving their liquidity and/or by making low-risk assets less attractive and leading to a "search-for-yield" (Maddaloni and Peydró (2010)). Wholesale funding can play an important role under either scenario, since it is a short-term, highly liquid source of funding that can be readily used to supply loans. Specifically, when these loans create maturity mismatches (e.g., long-term mortgage loans funded by short-term wholesale funding), banks bear the liquidity risk of continuously funding long-term loans by rolling over short-term debt, which are subject to conditions in these short-term funding markets. Therefore, a stronger link between wholesale funding and loan growth during periods of low policy rates can be consistent with increased risk taking.

An important step in the estimation of equation (2) is determining exactly when monetary policy rates have been "too low for too long" (Maddaloni and Peydró (2010)). In defining these periods, we take two different approaches. Our first approach can be defined as purely "backward-looking," or based on a historical estimate of monetary policy. Two specific measures are used under this approach. One is purely backward-looking in the sense that we examine the Canadian real overnight rate for our sample period to identify the periods when the rate is less than the 33rd percentile of the sample and the rate has been low for at least two quarters. The real overnight (policy) rate and the periods that correspond to low-for-long in our sample according to this backward-looking definition (*LowBack*) are given in Figure 1.

[INSERT FIGURE 1 HERE]

The other measure under the first approach is based on a historical estimate of monetary policy.[23] Using the Canadian quarterly macroeconomic data, we first estimate a version of the Taylor rule where the nominal interest rate is determined by inflation and output growth. Low-for-long periods are then defined to be when the residuals from this estimation are negative for two or more consecutive quarters. Figure 2 shows the resulting periods of low-for-long monetary policy rates as the shaded

[23]This measure replicates for Canada what Maddaloni and Peydró (2010) did for other countries.

periods.

[INSERT FIGURE 2 HERE]

Our second approach in identifying low-for-long periods uses the slope of the yield curve in order to be more "forward-looking." For low policy rates to increase risk taking through a "search-for-yield," the expectation of low policy rates in the future may also be necessary. In other words, banks may not take on risk in a low-rate environment if they are expecting monetary policy to tighten up in the near future. In order to identify when rates are low and are expected to remain low, we determine the periods in our sample when the policy rate is low and the yield curve is relatively flat or negative. We interpret a relatively flat or negatively sloped yield curve as an expectation of short-term interest rates remaining relatively constant or decreasing. Therefore, periods of a low policy rate and a flat yield curve correspond to a "low and expected to stay low" environment.

The "forward-looking" low-for-long periods are determined using (i) the 1-year Canadian treasury bill - 1-month Canadian treasury bill spread ($Low1yr$), or (ii) the 5-year Canadian government benchmark bond - 1-month Canadian treasury bill spread ($Low5yrs$). In either case, the instances when *both* the policy rate *and* the yield spread are below the sample period median are identified as periods when the policy rate is low and expected to stay low. These low-for-long periods and the corresponding yield curve spreads used in their identification are shown in Figures 3 and 4.

[INSERT FIGURES 3 AND 4 HERE]

Although these measures of low-for-long differ slightly among themselves, we observe that monetary policy rates were low-for-long during 2002–06 and in the aftermath of the recent financial crisis (between late 2008 and 2010). These observations are broadly in line with the low-for-long periods identified for the euro area and the United States by Maddaloni and Peydró (2010).

3.2.3 Wholesale Funding and Bank Lending During the Recent Crisis

We use a final specification in order to examine the link between wholesale funding and bank lending during the recent financial crisis:

$$\begin{aligned}\frac{\Delta(Loans)_{ijt}}{Loans_{ijt-1}} &= \alpha_1 \cdot Wholesale_{it-1} + \alpha_2 \cdot Wholesale_{it-1} \cdot Crisis_{i,t} \\ &+ \beta_1 \cdot Size_{it-1} + \beta_2 \cdot HighK_{it-1} \\ &+ \beta_3 \cdot LoanShare_{it-1} + \beta_4 \cdot ProvShare_{ijt-1} + \beta_5 \cdot Merger_{it} \\ &+ \theta \cdot Crisis_t + \gamma \cdot ProvinceControls_{jt} \\ &+ Qrt_j + Bank_i + \epsilon_{ijt}.\end{aligned} \tag{3}$$

In equation (3), $Crisis_{i,t}$ is a dummy that is set at one for the period 2007Q4–2009Q4, as in Allen and Paligorova (2011). Estimating this equation will help us compare our findings to similar studies in the literature that have looked at the funding-lending link in the syndicated loan market during the crisis (such as Ivashina and Scharfstein (2010); Allen and Paligorova (2011)). Since syndicated loans are large loans to commercial borrowers, they should be similar to the "big business loans" in our sample. If the estimation of equation (3), using "big business loans" as the dependent variable, yields findings similar to these existing studies, this would confirm the validity of our approach and further contribute to this literature.

3.3 Descriptive Statistics

[INSERT TABLE 1 HERE]

Table 1 provides the summary statistics for variables used in the analysis. The variables in the "Loan Growth" category include those that are bank-province-time specific with the corresponding ijt subscript. The "Funding" and "Bank" variables are at the bank-time level, indexed it (except $ProvShare_{ijt}$). The "Province" variables are at the province-time level (jt) and the "Macroeconomic" variables are indexed t. All variables are measured quarterly for the period 1994Q1–2010Q4.

For all specifications, observations where the loan growth rate exceeds 100% were eliminated from the sample in order to ensure that the results are not driven by outliers. Furthermore, observations that correspond to the first two quarters after entry and the last two quarters before exit were also dropped.

We rule out collinearity between the explanatory bank-time variables based on the correlation coefficients given in Table 2. Finally, Figures 5 and 6 display the aggregated values of different bank assets and liabilities from our data. Our focus on banks' use of wholesale funding is motivated by its observed volatility relative to other sources of funding, as seen in Figure 6. A large decline in the banking-sector wholesale funding is especially noticeable at the onset of the recent crisis, when its aggregate value declined by $219 billion or about 15% from its peak in November 2008 to the trough in July 2009.

[INSERT TABLE 2 HERE]

[INSERT FIGURES 5 AND 6 HERE]

4 Findings

This section discusses the main findings of the estimation of equations (1)-(3).

4.1 Changes in Funding Portfolios and Credit Supply

Results from equation (1) with the contemporaneous and lagged changes of wholesale funding and retail deposits give insights on how banks contemporaneously manage both sides of their balance sheets. Specifically, we observe whether banks allocate an increase in funding (i.e., wholesale funding or retail deposits) to overall bank loans and to different types of loans (i.e., mortgage or business). Understanding whether a specific funding type is channelled into bank loans in general and into a certain type of loans is important; it helps us understand the transmission mechanism of financial shocks through bank balance sheets onto real economic activities. For example, wholesale funding

is deemed a riskier source of funding than retail deposits with respect to funding liquidity risks (Brunnermeier and Pedersen (2009)). If wholesale funding is channelled to bank loans, then those loans and associated economic activities may indirectly be subject to shocks that adversely affect the wholesale funding markets. Hence, understanding funding-loan channels (i.e., how overall bank loans and particular types of loans are affected by funding shocks) contributes to the identification of the real sectors that likely incur financial disruptions in funding their projects through the bank intermediation channel. Table 3 reports the estimation results for equation (1).

[INSERT TABLE 3 HERE]

For each dependent variable, the table contains two specifications of demand-factor controls: (a) one with the province-time fixed effects in the left column, and (b) another with explicit provincial-level macroeconomic variables, together with province fixed effects, in the right column. The province-time fixed effects control any province-specific overall economic conditions that affect the demand for loans in the period. In contrast, the specification with explicit provincial-level macroeconomic variables together with province fixed effects illuminates what may be important province-level economic conditions for loan growth. Our expectation is that the combination of the province fixed effects along with the province-level macroeconomic variables will serve the same purpose as province-time fixed effects.

Table 3 also includes the standard specification tests for our IV/GMM model: namely, the p-value for the Hansen j-test of overidentifying restrictions and the (heteroscedasticity robust) Kleibergen-Paap F-test of weak instruments. All regressions under specification (b) satisfy both the overidentifying restrictions and the weak instrument tests. All regressions under specification (a) pass the overidentifying restrictions test, but the business loan-related regressions do not pass the weak instrument test.[24]

[24] As discussed in Cameron and Trivedi (2005), the main rule of thumb for weak instrument tests is $F > 10$, although $F > 5$ can also be used as a less strict rule. All but three of our loan types satisfy the "strict" rule of thumb, while all but two of our loan types satisfy the "less strict" rule.

Given that the Kleibergen-Paap F-test raises some concerns regarding the instrument validity in our province-time fixed effects, specification (a), we mostly focus our discussion on the results of specification (b) with explicit provincial-level macroeconomic variables and province fixed effects. We should note that this specification might be subject to omitted variable bias if the combination of the province fixed effects and the province-level macroeconomic variables fail to capture province-time-specific factors correlated with both the dependent variable and some of our independent variables. However, such an omitted variable bias is unlikely, since most of the coefficients are quite similar (in sign, size and statistical significance) across the two specifications, except for the wholesale funding-related variables. Given the instrument validity test results for the province-time fixed-effects regressions, we conclude that any differences in the two sets of regressions are mainly driven by possible weak instrument bias in the province-time fixed-effects specification and not by omitted variable bias in the provincial-level macroeconomic variables and province fixed-effects specification.

Regarding the credit supply effects of additional wholesale funding, the main channel appears to be through big business loans. A contemporaneous increase in wholesale funding positively and significantly raises the supply of both all business loans and big business loans. Specifically, when wholesale funding increases by 1% of total assets, all business and big business loans increase by 1.1% and 1.3%, respectively. The results with the province-time fixed effects are similarly positive and significant but larger in the estimates.[25] The lagged change in wholesale funding also positively and significantly raises credit supply in all business and big business loans, but at smaller magnitudes. These observations are consistent with those in the literature that find positive associations between wholesale funding and business loans.[26] A difference emerges, however, when observing the results with respect to other loans. The contemporaneous change in wholesale funding does not significantly affect mortgage loans, although a small positive effect is observed (0.1%) with respect to the lagged change in wholesale funding. Finally, total loan supply also significantly increases by 0.7% when the ratio of wholesale funding to total assets at time t increases by 1%. Similarly, a 1% increase in the lagged wholesale funding-use ratio is associated with a 0.1% increase in total loans.

[25] The instruments for these regressions are potentially weak, and the resulting bias appears to be positive.
[26] See Gozzi and Goetz (2010); Allen and Paligorova (2011).

Observations on the effects of the changes in retail deposits tell a different story. Funding both mortgage and all business loans appears to be the main channel for which banks use retail deposits. The table shows significant and positive effects of the contemporaneous changes in retail deposits on mortgage and total business loans as well as all loans, where a one-percentage-point increase in the fraction of total bank assets funded by retail deposits is associated with a 0.5% increase in mortgage loan growth, a 0.3% increase in the growth rate of all business loans, and a 0.7% increase in the total loan growth rate, all under the specification with explicit provincial-level macroeconomic variables and province fixed effects.[27]

A few notes are in order. First, since changes in retail deposits do not significantly impact big business loans but do affect all business loans, most of their effects are likely on small business loans. As mortgage and small business loans tend to be locally oriented, this may indicate that banks use local retail deposits for local loans. This idea is consistent with general observations that some banks decentralize decision making on how local funding (e.g., retail deposits in one area) is used to fund local assets (e.g., mortgage loans in the same area).[28] Likely through the impact on mortgages and small business loans, changes in retail deposits significantly affect total loans. Second, note that our preferred specification is the one with province fixed effects along with province-time macroeconomic variables. The specification with province-time fixed effects, however, also gives consistent results regarding retail deposits. As discussed above, the differences in the wholesale-funding-related results seem to be driven by the potential presence of weak instrument problems in the province-time fixed-effects specification. Looking at the results of our preferred specification, we conclude that an increase in both the contemporaneous and lagged wholesale funding raises the supply of business loans (large or small) and, as a result, total loans.

Regarding the level of wholesale funding (i.e., the ratio of wholesale funding to assets), banks with high levels of wholesale funding tend to increase mortgages, all business loans and total loans more than those with lower levels of wholesale funding. In addition, there is a set of bank control variables

[27] Lagged retail deposit changes also have significant effects on all business loans, but effects that are not significant or only weakly significant for all other loan types.

[28] See Committee on the Global Financial System (2010).

that speak to banks' portfolio diversification behaviour. The loan share of assets, *LoanShare*, negatively affects loan growth of all types, implying that banks may be diversifying between loans and non-loan assets. Also, the provincial share of bank's total assets, *ProvShare*, displays a negative impact on the growth of big business loans, suggesting geographical diversification of large business loans.

Under specification (b), regressors include provincial and economy-wide macro variables. The main benefit of analyzing this specification is to give insights into which macro variables potentially drive loan growth. For mortgages and large business loans, the lagged change in provincial unemployment rates significantly and negatively influence their loan growth rate, implying that the employment status may be an important factor in the demand for mortgages and large business activities. Moreover, the lagged level of interest rate, *IntRate*, significantly and negatively affects mortgage loan growth. Thus, when monetary policy rates are low, mortgage loans tend to grow faster. In contrast, the growth of all loans is positively affected by the lagged change in interest rates. These positive effects are likely coming from non-mortgage consumer loans and business loans.

Similarly, the term risk (*TermRisk*) decreases loan growth in mortgages. The term risk variable measures the risk premium associated with uncertainty over a time horizon. Since mortgages are long-term debt, the demand seems to decrease as the yield curve steepens and future uncertainty increases. The default risk, *DefRisk*, measures the degree of corporate-debt credit (i.e., default) risk. With an increase in the credit risk, total loan and mortgage loan growth rates increase. This may be the result of banks shifting their loan portfolio from business to mortgage loans. In addition to this portfolio reallocation, total loans may increase if the shift to more secured mortgage loans also comes from banks decreasing their non-loan investments, e.g., securities.

4.2 Wholesale Funding, Low-for-Long Interest Rates and Risk-Taking Behaviour

In this section, we analyze banks' potential risk-taking behaviour when interest rates are low for a long period of time. Specifically, as we discussed in section 3.2.2, we interpret risk-taking behaviour

as an expansion of loan supply while interest rates are low or are expected to be low for a long time. In doing so, we focus on the interaction of this loan supply behaviour with banks' dependence on wholesale funding (i.e., the ratio of wholesale funding to assets). Excessive credit growth during the low monetary policy rate period is a source of concern for central banks and financial stability policy-makers. Thus, it is important to identify which types of banks increase their credit supply during such periods and which part of their loan portfolio grows the fastest. In addition, as we saw during the crisis, market-based funding for banks can suddenly dry up and make debt rollover difficult for continuous financing of their longer-term assets (i.e., liquidity risk). Hence, by analyzing the interaction of credit growth and wholesale funding, we are capturing a link between two types of risks that contributed to the last crisis being systemic in nature: (a) potential excessive credit growth, which led to deleveraging and fire sales of bank assets, and (b) reliance on short-term market-based wholesale funding, which led to difficulties in debt rollover as funding-market liquidity declined.

[INSERT TABLE 4 HERE]

The estimation results of equation (2) are shown in Table 4. Results for each dependent variable are with the province-time fixed effects. As discussed in section 3.2.2, we analyze two approaches to measuring low-for-long monetary policy rates: one based on a backward-looking, or historical, measure, and the other based on expectations at each point in time. The table contains two panels, A and B. Panel A reports estimation results with a dummy variable *LowBack* (i.e., a backward-looking measure) and *LowTaylor* (i.e., a measure based on an historical estimate of monetary policy). Panel B reports results with *Low1yr* (i.e., a forward-looking measure of low-for-long over one year) and with *Low5yrs* (i.e., another forward-looking measure over five years).

The wholesale funding ratio is a measure of banks' reliance on wholesale funding and tends to be persistent over time.[29] We observe that banks with high wholesale funding reliance tend to supply all loans, mortgages and business loans faster than others that use less wholesale funding. During the periods of low-for-long monetary policy rates, the growth of all loans and business loans seems to be

[29] See Damar et al. (2013).

suppressed, shown by the negative signs with respect to the dummy variables *LowBack*, *LowTaylor*, *Low1yr* and *Low5yrs* (although insignificant for *Low5yrs* in all loans). In contrast, the low-for-long dummies (except for *Low5yrs*) are all insignificant in the growth of mortgage loans.

The interaction terms of the low-for-long dummies with wholesale funding tell a different story. For all loans, all four low-for-long specifications show a positive and significant coefficient estimate of the interaction term, implying that banks with high wholesale funding reliance tend to supply more loans during the periods of low-for-long monetary policy rates. This effect appears to partly come from mortgage loans rather than business loans, since the interaction terms show a positive and significant effect in the mortgage regressions but not so in the business loan regressions. In all business loans, the interaction terms involving *LowBack* and *Low1yr* even exhibit a negative and significant coefficient estimate. Since large business loan supply during low-for-long periods does not appear to change with wholesale funding, small business loans are likely declining for banks that rely on wholesale funding.

Summarizing the results above with respect to low-for-long monetary policy rate periods, two qualitative observations emerge: (i) on average for all banks, loan supply declines for all loans and business loans, and (ii) regarding banks' wholesale-funding reliance, those with more wholesale funding increase the supply of all loans and mortgage loans, but reduce that of small business loans. While the first observation suggests no potential risk taking, the second implies otherwise when banks rely on wholesale funding, especially with respect to mortgage loan supply, since it creates maturity mismatches and hence is subject to funding-market liquidity risk. One interpretation of higher loan supply is that, in order to increase lending, banks may reduce their lending standards. This interpretation is consistent with Maddaloni and Peydró (2010), who also observe a softening of lending standards in the euro area and the United States during periods of low short-term interest rates. Thus, we interpret this observation as a form of potential bank risk-taking behaviour with low-for-long monetary policy rates, especially since wholesale funding is subject to adverse funding-market liquidity shocks that can make debt rollover difficult. In the case of such shocks, there would be a transmission of risks from funding markets to bank credit supply. Our results identify the loan

types (i.e., all loans and mortgages) that are susceptible to this transmission of funding-market risks.

Regression results are also informative about the relative strength of the two qualitative results noted above. Quantitatively, an average decline in all loans during the low-for-long periods ranges between 16.8% ($Low1yr$) and 18.2% ($LowBack$ and $LowTaylor$), while a maximum increase from wholesale-funding-reliant banks (i.e., those with 100% wholesale funding) ranges between 3.7% ($Wholesale_{-1} \cdot Low1yr$) and 5.8% ($Wholesale_{-1} \cdot LowBack$). This comparison implies that, during the low-for-long periods, no evidence of potential risk-taking behaviour (i.e., excessive loan supply) with respect to all loans (and similarly for business loans) is observed. However, a similar comparison with respect to mortgage loans reveals that the increase from wholesale-funding-reliant banks (a maximum ranging from 4.5% to 8.1%) may be dominant, since average declines are not significant for the three specifications of low-for-long periods $LowBack$, $LowTaylor$ and $Low1yr$. Hence, if any potential risk-taking behaviour in loan supply exists, it is among wholesale-funding-reliant banks and with respect to mortgage loans, a particular concern considering the liquidity risk from maturity mismatches between long-term mortgage loans and short-term market-based funding.

Finally, another point is worth noting regarding loan supply behaviour of wholesale-funding-reliant banks during the low-for-long periods. These banks tend to increase mortgage loans while decreasing small business loans. This substitution between mortgage loans and business loans may be the result of the bank's risk management. In addition to mortgages being collateralized by underlying real estate properties, mortgages with high loan-to-value ratios are required to be insured in Canada. Hence, a shift in a bank's portfolio toward more mortgage loans and less business loans will reduce the bank's overall credit risk. If this is the main reason, the bank's *private* risk-taking behaviour with respect to the growth of overall loans during the low-for-long periods may be offset, to some extent, by this reduction in the riskiness of the loan portfolio. However, past experiences from housing market bubbles and subsequent crashes suggest that excessive mortgage loan supply by the financial sector as a whole can contribute to a bubble and, thus, could be considered as an economy-wide risk-taking behaviour. Claessens et al. (2008) show that economic recessions, which involve house price declines, result in more severe and longer economic downturns.

4.3 Wholesale Funding on Credit Supply during the Crisis

In this section, we discuss how credit supply behaviour of banks changed during the crisis and how this change interacted with reliance on wholesale funding. In the estimation, we use a dummy variable that takes the value of one between 2007Q4 and 2009Q4.

[INSERT TABLE 5 HERE]

The estimation results of equation (3) are shown in Table 5. Results are reported with the province-time fixed effects. For each dependent variable, the left column shows the estimates without the interaction term between the use of wholesale funding and the crisis dummy, and the right column shows estimates with the interaction term.[30]

The left column of each dependent variable in Table 5 reports the results consistently found in the literature that studies banks in other countries. The findings suggest that wholesale funding reliance positively and significantly affects loan growth in Canada. Banks with high reliance on wholesale funding tend to increase all loans, mortgages and business loans faster than do their low-wholesale-funding peers. The finding of the positive effects of wholesale funding on business loans confirms existing studies such as Gozzi and Goetz (2010) and Allen and Paligorova (2011). Results on other variables mostly confirm those reported in Table 4, suggesting the validity of these results.

In the right column of each dependent variable shown in the table, we observe that the *Crisis* dummy exhibits a negative and significant effect on all loans, implying that, on average, total loan growth declines across banks during the crisis. However, the interaction term of *Crisis* and wholesale funding reliance, with its positive and significant estimate, shows that banks with high wholesale funding reliance had relatively higher growth of all loans than the banks with less wholesale funding use. Similar to the previous results, the observations of all loans appear to come from the mortgage loans. The interaction term in the mortgage regression is positive and significant, as in the all-

[30]The specification without the interaction term is similar to many existing studies of wholesale funding (Ivashina and Scharfstein (2010); Gozzi and Goetz (2010); Allen and Paligorova (2011); Cornett et al. (2011)).

loan regression. Finally, large business loans appear to be negatively affected during the crisis for those banks with high wholesale funding reliance, since the interaction term in the big business loan regression exhibits a negative and significant estimate. This finding confirms that of Allen and Paligorova (2011), who analyze the change in syndicated loans during the crisis. The results regarding the rest of the variables are in line with the regressions without the *Crisis* dummy.

One potential reason for the increasing supply of mortgage loans during the crisis could be the set of government policies aimed at increasing the liquidity of the mortgage market. During the crisis period, the government implemented two policies that enhanced the liquidity of the mortgage market: the Insured Mortgage Purchase Program (IMPP) and an expansion of the Canada Mortgage Bonds (CMB) program. Canada Mortgage and Housing Corporation (CMHC – a Crown corporation of the government of Canada) implemented the IMPP in the autumn of 2008 and began purchasing high-quality mortgages from banks, thereby taking these mortgages off of banks' balance sheets. At around the same time, CMHC expanded the CMB program. CMBs are bonds backed by mortgages and are fully guaranteed, as to timely payment of principal and interest, by CMHC. These policies would have made banks shift their portfolios toward mortgage loans.

5 Conclusion

This paper studies one type of financial institution risk-taking behaviour, regarding the supply of credit and use of wholesale funding. The supply of bank loans that depend on wholesale funding (i.e., market-based funding) is subject to funding-market risks. When an adverse shock hits these short-term funding markets, available funds can quickly dry up, making it difficult for banks to continuously finance these loans. Based on this motivation, the three objectives of this paper are to analyze (i) how newly raised wholesale funding is allocated to different items on the asset side of the balance sheet; (ii) what types of loans wholesale-dependent banks issue during extended periods of low interest rates; and (iii) what types of loans wholesale-dependent banks issued during the recent financial crisis.

Using the provincial-level loan data from the regulatory reports of all federally chartered Canadian banks, the paper empirically estimates bank credit supply behaviour. Regarding the first objective, our analysis finds that wholesale funding is contemporaneously allocated to large business loans. An implication of this finding is that, when an adverse shock hits wholesale funding markets, businesses that receive large loans will likely be impacted.

Regarding the second objective, we find that, during extended periods of low interest rates, banks that rely on wholesale funding supply more loans (especially mortgages) than those with less wholesale funding. We argue that this is a type of increasing risk-taking behaviour during the prolonged periods of low interest rates. Supplying loans in the expectation that the funding rate will remain low for extended periods is risky, since the funding rate could suddenly reverse its course and go up. As market-based funding rates are likely more sensitive to the short-term rate, the cost of wholesale funding would quickly adjust accordingly, potentially making it difficult to continue to finance these loans. Finally, during the recent crisis, banks with wholesale funding increased mortgage loans, which in turn resulted in an increase in overall loans. This increase in loans is most likely a result of government policies aimed at improving the liquidity of the mortgage market. However, large business loans from wholesale-funding-reliant banks were negatively affected by the crisis.

These findings confirm the importance of wholesale funding in banks' credit supply, which supports real economic activities (e.g., housing or business investments). This use of short-term market-based wholesale funding exposes banks' loan books and the corresponding real economic activities to potential adverse funding-market shocks, as seen during the recent crisis. Understanding these issues is important for policy-makers and regulators, as a new international regulatory framework on bank liquidity standards continues to be discussed.

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Figures and Tables

Figure 1: Backward-Looking Low-for-Long Monetary Policy Rates in Canada, 1994-2010.

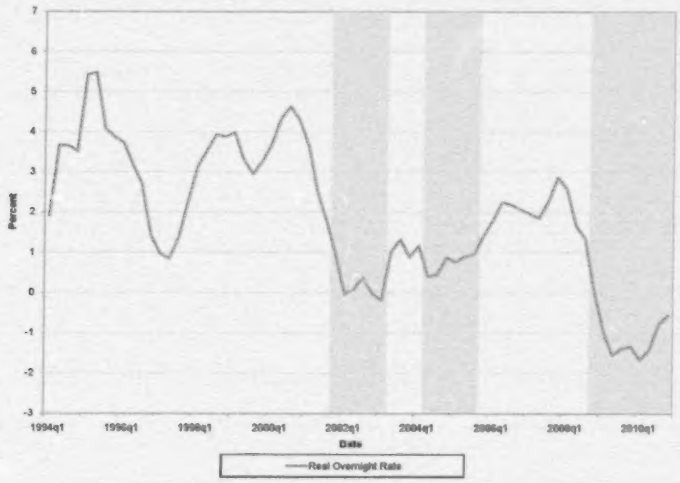

Figure 2: Taylor Rule Low-for-Long Monetary Policy Rates in Canada, 1994-2010.

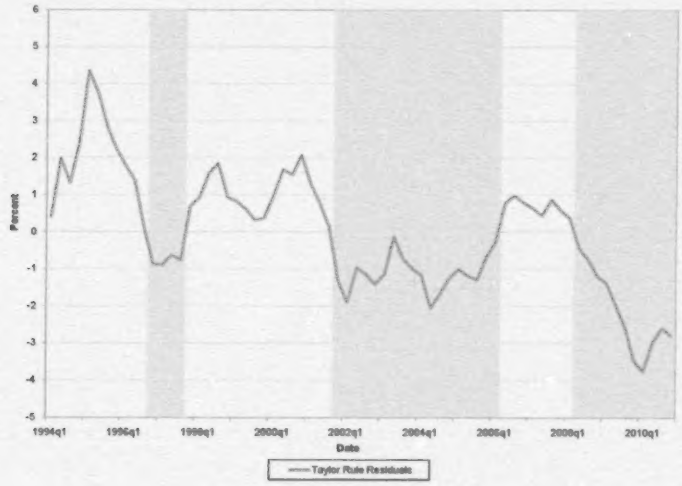

Figure 3: One-Year-Ahead Low-for-Long Monetary Policy Rates in Canada, 1994-2010.

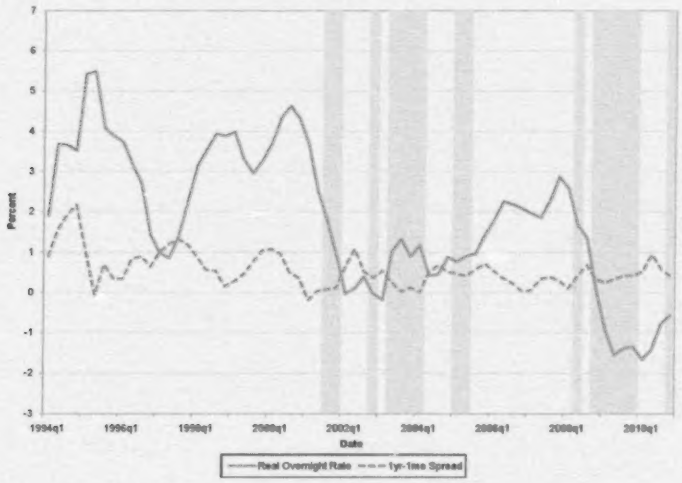

Figure 4: Five-Year-Ahead Low-for-Long Monetary Policy Rates in Canada, 1994-2010.

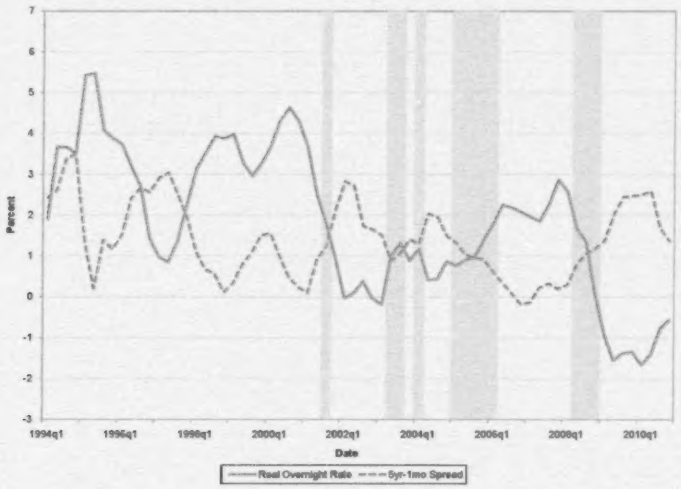

Figure 5: Aggregate Value of Bank Assets in Canada 1994-2010.

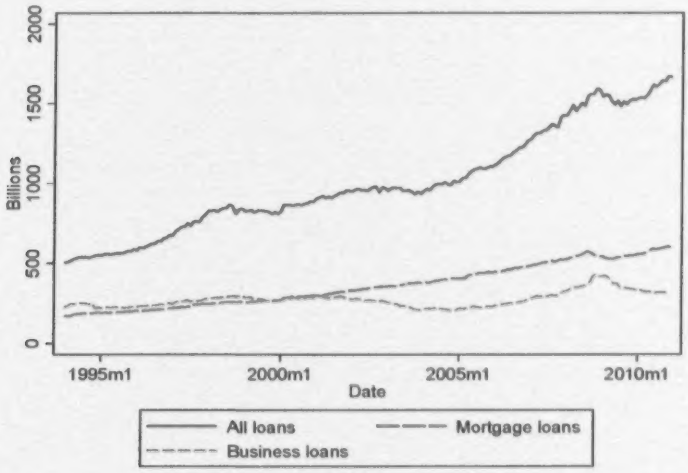

Figure 6: Aggregate Value of Bank Liabilities in Canada, 1994-2010.

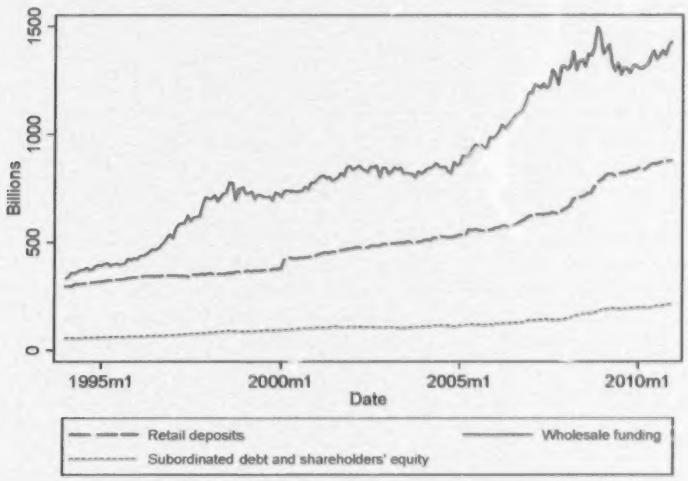

Table 1: This table provides summary statistics for the variables used in the analysis. The "Loan Growth" category includes bank-province-time specific variables with corresponding subscripts, i, j and t, respectively. The "Funding" and "Bank" variables are at the bank-time level, indexed i, t (except ProvShare_{ijt}). The "Province" variables are at the province-time level (j, t) and the "Macroeconomic" variables at the time level, t. All variables are at a quarterly frequency for the period 1994Q1-2010Q4.

	N	Mean	Median	Std. Dev.	Min	Max
Loan Growth:						
All Loans_{ijt}	18603	0.015	0.007	0.212	-0.999	0.999
$\text{Mortgage Loans}_{ijt}$	13522	0.017	0.004	0.187	-0.997	0.999
$\text{Business Loans}_{ijt}$	9528	0.004	-0.003	0.189	-0.999	0.989
$\text{Big Business Loans}_{ijt}$	6821	0.004	-0.007	0.249	-0.999	0.995
Funding:						
Wholesale_{it}	3404	0.402	0.423	0.309	0	0.945
Retail_{it}	3404	0.376	0.319	0.324	0	0.925
$\Delta\text{Wholesale}_{it}$	3404	0.004	0	0.091	-0.835	0.717
ΔRetail_{it}	3404	0.008	0.001	0.056	-0.659	0.679
Bank:						
Size_{it}	3404	14.275	13.752	2.401	8.541	20.450
HighK_{it}	3404	0.383	0	0.486	0	1
LoanShare_{it}	3404	0.666	0.708	0.212	0.001	0.990
Merger_{it}	3404	0.015	0	0.120	0	1
ProvShare_{ijt}	18603	0.128	0.028	0.206	0.000	1.418
Province:						
ΔUnemp_{jt}	680	-0.062	-0.099	0.694	-3.100	3.500
$\Delta\text{HousePr}_{jt}$	680	-0.004	-0.004	0.044	-0.243	0.235
ΔGDP_{jt}	680	0.030	0.028	0.107	-0.641	0.612
Macroeconomic:						
IntRate_t	68	1.843	1.819	1.776	-1.659	5.477
$\Delta\text{IntRate}_t$	68	-0.036	-0.055	0.643	-1.400	1.909
TermRisk_t	68	1.998	2.133	1.236	-0.036	3.966
DefRisk_t	68	0.867	0.731	0.608	0.301	3.408

Table 2: Correlation coefficients of all bank-level variables, excluding *Merger*.

	Wholesale	Retail	ΔWholesale	ΔRetail	HighK	Size	LoanShare
Wholesale	1						
Retail	-0.818	1					
ΔWholesale	0.082	-0.001	1				
ΔRetail	-0.133	0.194	0.004	1			
HighK	0.141	-0.342	-0.055	-0.103	1		
Size	0.241	-0.168	0.063	-0.025	-0.471	1	
LoanShare	-0.041	0.187	0.014	0.065	0.081	-0.090	1

Table 3: Impact of *changes* in both wholesale and retail funding on lending activity. All equations are estimated using the two-step GMM estimator. ΔWholesale is instrumented by the "liquidity-based" instruments discussed above. Errors are clustered at the bank-province level. Arbitrary heteroscedasticity and arbitrary intragroup correlation robust standard errors are given in parentheses. All regressions include bank, province and quarter fixed effects. *** is significant at 1%, ** and * are significant at 5% and 10%, respectively.

	All Loans		Mortgages		All Bus.		Big Bus.	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
ΔWholesale	-0.0427	0.666***	-0.850*	0.197	1.205*	1.077***	2.709***	1.277***
	(0.426)	(0.157)	(0.510)	(0.211)	(0.731)	(0.200)	(1.010)	(0.245)
ΔWholesale_1	0.00171	0.141***	-0.0875	0.117**	0.303**	0.271***	0.504***	0.302***
	(0.0832)	(0.0381)	(0.0925)	(0.0510)	(0.120)	(0.0498)	(0.173)	(0.0739)
Wholesale_1	0.0776**	0.123***	0.0862**	0.0685**	0.204***	0.187***	0.259**	0.140*
	(0.0313)	(0.0331)	(0.0402)	(0.0341)	(0.0663)	(0.0412)	(0.115)	(0.0731)
ΔRetail	0.626***	0.687***	0.457***	0.465***	0.380***	0.291**	0.331	0.125
	(0.0766)	(0.0710)	(0.0770)	(0.0754)	(0.137)	(0.142)	(0.235)	(0.198)
ΔRetail_1	0.0861	0.106**	0.0842	0.148**	0.242**	0.207**	0.223	0.166
	(0.0603)	(0.0535)	(0.0739)	(0.0648)	(0.102)	(0.0854)	(0.254)	(0.235)
Size_1	-0.00325	-0.00116	-0.0124	-0.0133*	-0.0155**	-0.0201***	0.00807	0.00156
	(0.00599)	(0.00552)	(0.00795)	(0.00698)	(0.00730)	(0.00718)	(0.0203)	(0.0148)
HighK_1	-0.00631	-0.00387	0.0165	0.00573	-0.0346*	-0.0347**	-0.0505	-0.0126
	(0.00979)	(0.00990)	(0.0134)	(0.0122)	(0.0181)	(0.0144)	(0.0329)	(0.0204)
LoanShare_1	-0.0813***	-0.104***	-0.0704**	-0.112***	-0.213***	-0.175***	-0.311***	-0.143**
	(0.0269)	(0.0256)	(0.0313)	(0.0259)	(0.0827)	(0.0443)	(0.0900)	(0.0608)
ProvShare_1	-0.0165	-0.0261	-0.0216	-0.0238	-0.0176	-0.0231	-0.0839**	-0.0692***
	(0.0167)	(0.0161)	(0.0170)	(0.0169)	(0.0160)	(0.0167)	(0.0328)	(0.0234)
Merger	0.00749	0.00928	-0.00471	-0.00348	0.0115	0.00955	-0.0151	0.0118
	(0.00850)	(0.00696)	(0.00509)	(0.00413)	(0.0120)	(0.00809)	(0.0296)	(0.0148)
ΔUnemp_1		-7.48e-05		-0.000977		-0.00371		0.00252
		(0.00236)		(0.00230)		(0.00355)		(0.00563)
ΔUnemp_2		-0.00342		-0.00507*		-0.00266		-0.0130**
		(0.00292)		(0.00288)		(0.00318)		(0.00623)
ΔHousePr_1		0.0444		-0.0605		-0.0666		-0.0152
		(0.0479)		(0.0515)		(0.0617)		(0.119)
ΔHousePr_2		0.00153		-0.0589		-0.000112		-0.0234
		(0.0507)		(0.0460)		(0.0527)		(0.0860)
ΔGDP_1		-0.0231		-0.00445		0.0272		0.0511
		(0.0145)		(0.0152)		(0.0199)		(0.0433)
ΔGDP_2		-0.00957		0.0201		0.0277		0.0184
		(0.0136)		(0.0162)		(0.0188)		(0.0399)
IntRate_1		0.00281		-0.00423**		0.000256		0.00275
		(0.00187)		(0.00203)		(0.00224)		(0.00434)
ΔIntRate_1		0.00483*		-0.00383		0.00348		0.00216
		(0.00253)		(0.00281)		(0.00380)		(0.00534)
TermRisk		-4.28e-05		-0.00529**		-0.00367		-0.00498
		(0.00215)		(0.00237)		(0.00303)		(0.00574)
DefRisk		0.0119***		0.0287***		0.00347		0.000373
		(0.00331)		(0.00431)		(0.00371)		(0.00609)
Constant	0.00321*	0.0233***	0.00233	0.0188***	0.00172	0.00762	0.00346	0.0158*
	(0.00166)	(0.00594)	(0.00182)	(0.00602)	(0.00153)	(0.00794)	(0.00225)	(0.00894)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prov FE	No	Yes	No	Yes	No	Yes	No	Yes
Prov-Time FE	Yes	No	Yes	No	Yes	No	Yes	No
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,095	12,691	9,689	9,445	7,792	7,655	5,627	5,483
Kleibergen-Paap F	8.171	45.658	12.232	39.068	2.949	42.797	2.243	56.318
Hansen Test p-value	0.1627	0.7297	0.1782	0.1459	0.2668	0.5443	0.358	0.4896

Table 4: Loan growth regressions with interactions between wholesale funding use and the low-for-long interest rate. Errors are clustered at the bank-province level. Standard errors are given in parentheses. *** is significant at 1%, ** and * are significant at 5% and 10%, respectively.

	All Loans		Mortgages		All Bus.		Big Bus.	
Panel A								
$Wholesale_{-1}$	0.0774***	0.0728**	0.121***	0.115***	0.166***	0.160***	0.0733	0.0639
	(0.0298)	(0.0304)	(0.0383)	(0.0388)	(0.0424)	(0.0426)	(0.0751)	(0.0761)
$Wholesale_{-1}$ · LowBack	0.0579***		0.0810***		-0.0435*		0.109	
	(0.0147)		(0.0186)		(0.0236)		(0.108)	
$Wholesale_{-1}$ · LowTaylor		0.0504***		0.0672***		-0.0130		0.00261
		(0.0133)		(0.0155)		(0.0192)		(0.0431)
$Size_{-1}$	-1.67e-05	-0.000435	-0.0132*	-0.0131*	-0.0145*	-0.0143*	0.0111	0.0134
	(0.00656)	(0.00651)	(0.00711)	(0.00714)	(0.00812)	(0.00809)	(0.0150)	(0.0150)
$HighK_{-1}$	-0.0174*	-0.0176*	-0.00661	-0.00759	-0.0170	-0.0173	0.00829	0.00909
	(0.00997)	(0.00996)	(0.0118)	(0.0118)	(0.0123)	(0.0124)	(0.0146)	(0.0147)
$LoanShare_{-1}$	-0.0726***	-0.0716***	-0.129***	-0.129***	-0.159***	-0.156***	-0.114**	-0.111**
	(0.0256)	(0.0256)	(0.0252)	(0.0253)	(0.0355)	(0.0353)	(0.0560)	(0.0562)
$ProvShare_{-1}$	-0.0358**	-0.0358**	-0.0243	-0.0236	-0.00823	-0.00855	-0.0534**	-0.0527**
	(0.0162)	(0.0161)	(0.0151)	(0.0151)	(0.0192)	(0.0193)	(0.0257)	(0.0260)
Merger	0.00195	0.00260	0.00298	0.00336	0.0288***	0.0289***	0.0308**	0.0317**
	(0.00855)	(0.00858)	(0.00604)	(0.00612)	(0.00974)	(0.00977)	(0.0139)	(0.0140)
LowBack	-0.182***		-0.0706		-0.147***		-0.411***	
	(0.0626)		(0.0431)		(0.0511)		(0.0938)	
LowTaylor		-0.182***		-0.0695		-0.160***		-0.440***
		(0.0627)		(0.0434)		(0.0517)		(0.0931)
Constant	0.0988	0.107	0.328***	0.330***	0.386***	0.385***	0.0430	0.00720
	(0.102)	(0.102)	(0.111)	(0.111)	(0.135)	(0.135)	(0.267)	(0.266)
Observations	17,693	17,693	12,929	12,929	9,175	9,175	6,486	6,486
R-squared	0.133	0.133	0.170	0.170	0.107	0.107	0.157	0.157
Panel B								
$Wholesale_{-1}$	0.0875***	0.0910***	0.135***	0.140***	0.161***	0.155***	0.0690	0.0585
	(0.0297)	(0.0295)	(0.0387)	(0.0390)	(0.0419)	(0.0418)	(0.0750)	(0.0749)
$Wholesale_{-1}$ · Low1yr	0.0370**		0.0546***		-0.0525**		-0.0404	
	(0.0168)		(0.0185)		(0.0259)		(0.0491)	
$Wholesale_{-1}$ · Low5yrs		0.0382**		0.0453**		0.00681		0.0845
		(0.0165)		(0.0185)		(0.0310)		(0.0516)
$Size_{-1}$	-0.0000572	-0.000299	-0.0133*	-0.0134*	-0.0142*	-0.0143*	0.0121	0.0150
	(0.00658)	(0.00654)	(0.00715)	(0.00718)	(0.00805)	(0.00806)	(0.0148)	(0.0148)
$HighK_{-1}$	-0.0170*	-0.0169*	-0.00733	-0.00777	-0.0168	-0.0178	0.00877	0.00891
	(0.0100)	(0.0100)	(0.0120)	(0.0120)	(0.0122)	(0.0123)	(0.0148)	(0.0147)
$LoanShare_{-1}$	-0.0717***	-0.0704***	-0.129***	-0.129***	-0.159***	-0.155***	-0.113**	-0.108*
	(0.0258)	(0.0259)	(0.0255)	(0.0256)	(0.0352)	(0.0353)	(0.0559)	(0.0558)
$ProvShare_{-1}$	-0.0355**	-0.0359**	-0.0240	-0.0240	-0.00832	-0.00872	-0.0531**	-0.0528**
	(0.0162)	(0.0161)	(0.0151)	(0.0152)	(0.0192)	(0.0192)	(0.0259)	(0.0262)
Merger	0.000710	0.000467	0.000830	6.54e-05	0.0289***	0.0292***	0.0312**	0.0325**
	(0.00862)	(0.00859)	(0.00619)	(0.00621)	(0.00979)	(0.00974)	(0.0140)	(0.0139)
Low1yr	-0.168***		-0.0493		-0.166***		-0.436***	
	(0.0625)		(0.0421)		(0.0498)		(0.0907)	
Low5yrs		-0.0655		-0.115**		-0.0997*		-0.185*
		(0.0514)		(0.0505)		(0.0550)		(0.0942)
Constant	0.0944	0.0958	0.323***	0.323***	0.384***	0.387***	0.0277	-0.0185
	(0.103)	(0.102)	(0.112)	(0.112)	(0.134)	(0.135)	(0.264)	(0.263)
Observations	17,693	17,693	12,929	12,929	9,175	9,175	6,486	6,486
R-squared	0.132	0.132	0.169	0.168	0.107	0.107	0.157	0.157

Table 5: Loan growth regressions with interactions between wholesale funding use and the crisis-period dummy. Errors are clustered at the bank-province level. Standard errors are given in parentheses. *** is significant at 1%, ** and * are significant at 5% and 10%, respectively.

	All Loans		Mortgages		All Bus.		Big Bus.	
$Wholesale_{-1}$	0.0935***	0.0839***	0.142***	0.128***	0.155***	0.155***	0.0647	0.0806
	(0.0294)	(0.0299)	(0.0391)	(0.0395)	(0.0417)	(0.0421)	(0.0748)	(0.0752)
$Wholesale_{-1} \cdot Crisis$		0.0475***		0.0606***		0.00403		-0.136**
		(0.0175)		(0.0221)		(0.0314)		(0.0544)
$Size_{-1}$	-0.0000680	0.000662	-0.0137*	-0.0126*	-0.0143*	-0.0143*	0.0133	0.0104
	(0.00661)	(0.00660)	(0.00719)	(0.00719)	(0.00808)	(0.00808)	(0.0146)	(0.0150)
$HighK_{-1}$	-0.0170*	-0.0178*	-0.00728	-0.00801	-0.0176	-0.0178	0.00908	0.0126
	(0.0101)	(0.0101)	(0.0120)	(0.0121)	(0.0123)	(0.0122)	(0.0147)	(0.0149)
$LoanShare_{-1}$	-0.0711***	-0.0739***	-0.130***	-0.129***	-0.155***	-0.155***	-0.111**	-0.114**
	(0.0260)	(0.0260)	(0.0257)	(0.0252)	(0.0354)	(0.0352)	(0.0553)	(0.0546)
$ProvShare_{-1}$	-0.0352**	-0.0356**	-0.0238	-0.0242	-0.00863	-0.00873	-0.0528**	-0.0505*
	(0.0162)	(0.0162)	(0.0152)	(0.0152)	(0.0192)	(0.0192)	(0.0260)	(0.0256)
Merger	-0.000501	-0.000557	-0.00105	-0.00149	0.0291***	0.0291***	0.0316**	0.0318**
	(0.00863)	(0.00874)	(0.00617)	(0.00645)	(0.00973)	(0.00973)	(0.0139)	(0.0140)
Crisis		-0.193***		0.115		0.0526		0.146
		(0.0476)		(0.0833)		(0.107)		(0.111)
Constant	-0.0126	0.0870	0.256**	0.315***	0.214	0.386***	-0.421	0.0482
	(0.104)	(0.103)	(0.116)	(0.112)	(0.141)	(0.135)	(0.300)	(0.265)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prov FE	No	No	No	No	No	No	No	No
Prov-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,693	17,693	12,929	12,929	9,175	9,175	6,486	6,486
R-squared	0.132	0.132	0.168	0.169	0.107	0.107	0.157	0.157

Appendix

A Estimation with Retail Deposits at Provincial Level

In this section, we re-estimate equation (1) by redefining retail deposit variables from those of the bank-time level to the bank-province-time level: $\Delta RetailProv_{ijt}$ and $\Delta RetailProv_{ijt-1}$.[31] All else remains the same. Table A1 reports the estimation results.

Compared to the findings in Table 3, results with respect to wholesale funding variables are robust and mostly unchanged (qualitatively and quantitatively). Regarding results with respect to retail deposits, they are also unchanged qualitatively and quantitatively, except for those with total business loans. In Table A1, the contemporaneous changes in retail deposits are no longer significant under both specification (a) and (b), although the lagged effects of retail deposits are still positive and significant. This result may suggest that the contemporaneous funding of small business loans by retail deposits is partly managed by the bank headquarters. That is, if retail deposits from one region are transferred to another, the contemporaneous effects of retail deposit at the bank level can be positive and significant while not being significant at the bank-province level. However, since the lagged effects of retail deposits on total business loans are positive and significant, cross-provincial transfers of retail deposits for small business loans may be a temporary phenomenon.

Overall, the main results from Table 3 are intact when we estimate equation (1) using retail deposits at the bank-province-time level. Wholesale funding is mainly channelled to business loans (especially large business loans), while retail deposits are mainly used to finance mortgage loans and small business loans.

[31] Specifically, $\Delta RetailProv_{ijt} \equiv \frac{Retail\ Deposit\ in\ Province\ j\ at\ Time\ t - Retail\ Deposit\ in\ Province\ j\ at\ Time\ t-1}{Total\ Assets\ of\ Bank\ i\ at\ Time\ t}$, and $\Delta RetailProv_{ijt-1}$ similarly defined.

Table A1: Impact of *changes* in both wholesale and retail funding on lending activity, where the change in retail funding is calculated at the bank-province-time level and normalized by the total assets of the bank ($\Delta RetailProv$). All equations are estimated using the two-step GMM estimator. ΔWholesale is instrumented by the "liquidity-based" instruments discussed above. Errors are clustered at the bank-province level. Arbitrary heteroscedasticity and arbitrary intragroup correlation robust standard errors are given in parentheses. All regressions include bank, province and quarter fixed effects. *** is significant at 1%, ** and * are significant at 5% and 10%, respectively.

	All Loans		Mortgages		All Bus.		Big Bus.	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
ΔWholesale	-0.334	0.709***	-1.043**	0.242	1.081	1.081***	2.692***	1.290***
	(0.442)	(0.160)	(0.528)	(0.217)	(0.705)	(0.200)	(1.019)	(0.245)
ΔWholesale$_{-1}$	-0.0496	0.152***	-0.106	0.125**	0.286**	0.273***	0.503***	0.304***
	(0.088)	(0.039)	(0.097)	(0.051)	(0.117)	(0.049)	(0.174)	(0.074)
Wholesale$_{-1}$	0.0916***	0.150***	0.121***	0.0942**	0.207***	0.194***	0.261**	0.143*
	(0.033)	(0.033)	(0.044)	(0.037)	(0.066)	(0.041)	(0.114)	(0.073)
ΔRetailProv	0.612***	0.674***	0.405***	0.457***	0.307	0.250	0.134	-0.151
	(0.119)	(0.138)	(0.155)	(0.170)	(0.239)	(0.239)	(0.384)	(0.317)
ΔRetailProv$_{-1}$	0.204*	0.164**	0.0861	0.103	0.311**	0.290**	0.270	0.316
	(0.116)	(0.0780)	(0.110)	(0.0787)	(0.145)	(0.138)	(0.419)	(0.381)
Size$_{-1}$	-0.00793	-0.000767	-0.0179**	-0.0157**	-0.0176**	-0.0220***	0.00487	-4.13e-05
	(0.007)	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.019)	(0.015)
HighK$_{-1}$	-0.00801	-0.00903	0.0165	0.00268	-0.0329*	-0.0350**	-0.0517	-0.0139
	(0.011)	(0.011)	(0.015)	(0.013)	(0.018)	(0.015)	(0.033)	(0.020)
LoanShare$_{-1}$	-0.0676**	-0.110***	-0.0850**	-0.141***	-0.207**	-0.180***	-0.320***	-0.150**
	(0.032)	(0.029)	(0.034)	(0.028)	(0.082)	(0.045)	(0.092)	(0.061)
ProvShare$_{-1}$	-0.0253	-0.0352**	-0.0312*	-0.0334**	-0.0233	-0.0285*	-0.0862***	-0.0700***
	(0.018)	(0.017)	(0.017)	(0.017)	(0.016)	(0.017)	(0.032)	(0.024)
Merger	0.00788	0.00836	-0.00491	-0.00399	0.0142	0.0103	-0.0155	0.0119
	(0.009)	(0.007)	(0.005)	(0.004)	(0.012)	(0.008)	(0.029)	(0.015)
ΔUnemp$_{-1}$		-0.000914		-0.00189		-0.00402		0.00257
		(0.002)		(0.002)		(0.003)		(0.006)
ΔUnemp$_{-2}$		-0.00447		-0.00570*		-0.00312		-0.0132**
		(0.003)		(0.003)		(0.003)		(0.006)
ΔHousePr$_{-1}$		0.0558		-0.0593		-0.0659		-0.0159
		(0.049)		(0.052)		(0.061)		(0.119)
ΔHousePr$_{-2}$		0.0231		-0.0439		0.00815		-0.0216
		(0.052)		(0.047)		(0.052)		(0.087)
ΔGDP$_{-1}$		-0.0176		0.00347		0.0272		0.0525
		(0.015)		(0.015)		(0.020)		(0.043)
ΔGDP$_{-2}$		0.00229		0.0291*		0.0305		0.0196
		(0.014)		(0.016)		(0.019)		(0.039)
IntRate$_{-1}$		0.00445**		-0.00318		0.000298		0.00269
		(0.002)		(0.002)		(0.002)		(0.004)
ΔIntRate$_{-1}$		0.00464*		-0.00390		0.00405		0.00213
		(0.002)		(0.003)		(0.004)		(0.005)
TermRisk		0.000559		-0.00501**		-0.00387		-0.00546
		(0.002)		(0.002)		(0.003)		(0.006)
DefRisk		0.0132***		0.0306***		0.00438		0.00132
		(0.003)		(0.004)		(0.004)		(0.006)
Constant	0.00323*	0.0259***	0.00221	0.0210***	0.00156	0.00849	0.00353	0.0159*
	(0.002)	(0.006)	(0.002)	(0.006)	(0.002)	(0.008)	(0.002)	(0.009)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prov FE	No	No	Yes	Yes	No	No	Yes	Yes
Prov-Time FE	Yes	Yes	No	No	Yes	Yes	No	No
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,095	12,691	9,689	9,445	7,792	7,655	5,627	5,483
Kleibergen-Paap F	25.666	96.089	39.735	75.06	9.993	68.302	6.247	67.204
Hansen Test p-value	0.0561	0.462	0.234	0.0942	0.310	0.557	0.361	0.439